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INTERNATIONAL GEOPHYSICAL COOPERATION PROGRAM--SOVIET-BLOC ACTIVITIES

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I. ROCKETS AND ARTIFICIAL EARTH SATELLITES

Motion of Artificial Satellites

The study of the rotational motion of an artificial celestial body around its center of inertia is of great importance. However, this problem is very difficult from the mathematical viewpoint and therefore it is of interest to consider preliminarily its simplest cases.

In the present paper, one of the simplest problems of this kind is considered, namely, the motion of an artificial satellite around the Earth, which is assumed to be a homogeneous sphere; the satellite itself having an arrow-like form, can be likened dynamically to a rectilinear, homogeneous material segment, which is termed a "rod."

No other forces besides the attraction of the Earth are taken into account. The resistance of the Earth's atmosphere is also ignored. Under these conditions, the differential equations of the relative motion of the satellite around the Earth allow some particular solutions, corresponding to the simplest motions of the satellite, which are termed "regular."

In these regular motions the center of inertia of the satellite, i.e., the center of the rod, describes a circular orbit around the Earth and the rod itself keeps an unchangeable orientation relative to this orbit. Here, three cases are possible, each corresponding to a regular motion of the rod. These are termed briefly "arrow," "floating bar," and "spoke."

In the first case, "arrow," the rod constantly coincides with the tangent to the circular orbit of its own center; in the second, "floating bar," the rod stays constantly perpendicular to the plane of the circular orbit of its center; in the third, "spoke," the rod constantly coincides with the radius of the circular orbit of its center.

These regular motions of the rod were indicated in a previous paper ("Ob odnom chastnom sluchaye o postupatel'novrashchatel'nom dvizhenii dvukh tel" [A particular case of progressing and rotating motion of two bodies]), by the author. Here the stability of the above-mentioned regular motions in the sense of A. M. Lyapunov, i.e., the possibility of a prolonged conservation of motion, close to one of the regular motions, is investigated.

The problem at first is solved without any simplifying assumptions and then the case is considered when the length of the rod is exceedingly small in comparison to the radius of the circular orbit of its center, which also corresponds to a true case of the motion of an artificial Earth satellite. It was found that in the "arrow" case regular motion on the whole is unstable; "floating bar," unstable, without doubt; and "spoke," may be stable, at least in the first approximation. ("On the Stability of Regular Motions of Artificial Celestial Bodies," by G. N. Duboshin, Sternberg State Astronomical Institute; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 4, Jul/Aug 59, pp 723-733)

Book on Lunik I

K. Gil'zin, Candidate of Technical Sciences, gives the following information in a review of the book Sovetskaya Raketa Issleduyet Kosmos (A Soviet Rocket Is Investigating Outer Space) by V. Levantovskiy, V. Leshkovtsev, and I. Rakhlin, (Fizmatiz,1959, 128 pp).

The book is dedicated to Lunik I, which was launched toward the Moon on 2 January 1959. The successes achieved by Soviet astronautics were the result of work by the combined forces of a number of sciences; astronomy, rocket engineering, radio electronics, physics, chemistry, biology, etc. The progress in these fields of science is described by the authors. All said in the book on the methods of solving problems of astronautics, on the goals of space flights and their value for science, and even the plans for conquering the cosmos, are true also for today.

The first stages of the plan for investigating the cosmos described by the authors have already been accomplished by Soviet scientists, and perhaps somewhat earlier than appeared possible at the time the book was written.

The book is divided into four principal parts. The first part presents astronomical information concerning the Earth's nearest neighbors in circumsolar space. That part of the Universe in which the Soviet cosmic rockets are flying is described.

The second part deals with the means used for space travel, rockets. Here, information on the field of rocket engineering is given: how force moves cosmic rockets and artificial earth satellites and how they are constructed. Data on all the satellites launched by the USSR and the US up to the moment the book was written are given. The laws of motion of celestial bodies, the first Soviet artificial planet [Lunik I], routes for flights to the Moon and to other celestial bodies in the solar system, and finally, how the movement of cosmic rockets is observed, are discussed.

The third part concerns the aims and substance of the space investigations, which have been made with the aid of rockets. Also discussed are the study of the structure of the upper layers of the atmosphere and cosmic rays, the recording of meteor particles, the Earth's magnetic field, and the study of the corpuscular streams emitted by the Sun and their effect on the Earth's atmosphere.

The book is rich in scientific facts obtained by means of rockets and artificial Earth satellites. Included are data on the "corona of the Earth," the radiation belt surrounding our planet in the plane of the equator. The opinions of various scientists on the origin of this aureole are given.

The last part of the book, the fourth, deals with problems of the future. In it are discussed automatic rockets, probes to planets of the solar system, and also future expeditions of astronauts on the Moon and planets. The motors for future interplanetary craft, including the ion and photon rockets, and the appearance of these interplanetary craft and space stations are described.

The book as a whole gives a good presentation of the problems of astronautics. It is written in simple and clear language, without the use of mathematical devices. The latter, however, sometimes detracts from the book. None of Tsiolkovskiy's formulas, on which rocket dynamics and astronautics are based, are given, thereby making an understanding of the conclusions of the formulas, which the authors use widely, difficult.

The section dealing with rocket engineering is not as successfully presented as has been done by some other authors.

Despite these and a few other shortcomings, the over-all positive value of the book remains. ("Space Prospectors," by K. Gil'zin, Candidate of Technical Sciences; Moscow, Promyshlenno-Ekonomicheskaya Gazeta, 11 Nov 59, p 4)

II. UPPER ATMOSPHERE

Study of Atmospheric Ozone

The illuminations at different phases of a lunar eclipse are calculated for a standard atmosphere without ozone and also for an ozone admixture with different distribution, according to height above sea-level. The results obtained so far are summarized in a table showing: (1) the different limiting heights in the atmosphere illuminated by passing solar rays as they appear from the Moon; (2) the corresponding phase angles for the observed area of the Moon, i.e., the angular distance of the area from the center of the Earth's shadow; (3) the illumination J/J_0 for $\lambda = 0.5\ \mu$, calculated for a standard atmosphere without ozone in units of illumination produced by an uneclipsed Sun; (4) and (5) the same as (3), but for an ozone admixture with a total vertical thickness equal to 0.031 and height of maximum concentration 21 and 26 km, respectively; and (6) and (7) the absorption due to ozone under these conditions expressed in stellar magnitudes.

The inspection of photometric curves, similar to those in figures 2-6 in the article, permits the determination of the distribution of ozone with height and also the total amount of ozone in the atmosphere. ("Investigation of Atmospheric Ozone by Photometry of Lunar Eclipses," by V. G. Fesenkov, Institute of Astrophysics, Academy of Sciences Kazakh SSR; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 4 Jul/Aug 59, pp 564-572)

Homogeneity of the Ionosphere

During the observations of radio stars by the radio interferometric method on the meter wave range, a distinct interferometric pattern is observed in most cases when the ionosphere is not disturbed. This makes an estimation of the upper limit of the degree of nonuniformity of the electron plasma of the metagalaxy, Galaxy, zodiacal light, and ionosphere possible. The estimate for a quiet ionosphere shows that if the size of the nonuniformities is 3-5 kilometers, the total number of electrons in these nonuniformities comprises only 0.3 — 0.4 percent of the total number of electrons in a column of unit cross section. ("The Degree of Homogeneity of a Quiet Ionosphere," by V. V. Vitkevich, Physics Institute imeni Lebedev, Academy of Sciences USSR; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 4, Jul/Aug 59, pp 623-625)

Solar Noise Storms

Two types of burstsof short duration of solar radio emission peaks are described: narrow-band with a bandwidth up to megacycles per second and wide band, with a band width of about 12-15 megacycles per second. ("Spectrum of Peaks of Solar Radio Emission," by V. V. Vitkevich, Physics Institute imeni Lebedev, Academy of Sciences USSR; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 4, Jul/Aug 59, pp 641-642)

Radio Noise by the Moon

The temperature of radio emission of the central part of the Moon's disc on 1.63 centimeter wave was measured in relation to the phase of the Moon. The dependence obtained can be approximated sufficiently well by the expression $T_1 = 224^\circ - 36^\circ \cos (\Omega t - 40^\circ)$. The values of the damping coefficient of the electromagnetic wave $\varkappa = 0.2 \text{ cm}^{-1}$ and equivalent electroconductivity $\sigma = 7.9 \times 10^8$ CGSE for lunar material were found from a comparison with the theoretical relationship. ("Radio Emission of the Moon on 1.63 Centimeters," by M. R. Zelinskaya, V. S. Troitskiy and L. I. Fedoseyev, Scientific Research Radiophysics Institute, Gor'kiy University; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 4, Jul/Aug 59, pp 643-647)

Geomagnetic Disturbances and Solar Activity

The superposed epoch method is applied to geomagnetic disturbances for the period 1942-1944. The moment of CMP [Central Meridian Passage] of plages plotted on the maps of an article by E. P. Mustel' and A. S. Dvoryashin (Astron. Zh., Vol 35, No 3, 1958) is taken as a zero point. Statistical curves of geomagnetic disturbances are obtained for the periods May 1942-April 1943, May 1943-May 1944, and for all the period 1942-1944.

In 1943, the radiality of streams from plages was disturbed (plages at $L \approx 80^\circ$ according to the above article). Correspondingly two maxima and one minimum are found if the superposed epoch method is applied to plages in "favorable" and in "unfavorable" hemispheres of the sun. ("Statistics of Geomagnetic Disturbances and Solar Active Regions," by A. S. Dvoryashin, Crimean Astrophysical Observatory, Academy of Sciences USSR; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 4, Jul/Aug 59, pp 620-622)

Study of Solar Prominences

Experimental determination of the parameters of physical conditions in prominences are considered. The kinetic temperature, calculated from the half-widths of lines broadened by the Doppler effect, is $T_{kin} = 6000 - 900$ degrees. The electron density found from the Stark effect, which affects the half-widths and the far wings of hydrogen line profiles and also the number of lines in the series, is equal to $n_e = 10^{12}$ cm^{-3}. The analysis of the spectrum of metals leads to similar values. From the data obtained by Redman it follows that n_e increases with height in the chromosphere. For prominences

$$\int_0^\infty n_e dH = 10^{19} \text{ and } \int_0^\infty n_e^2\, dH = 10^{30},$$

which, taking into account the heterogeneity of the prominence, also give a value of $n_e \sim 10^{12}$ cm^{-3}. Hydrogen concentration in prominences is $n(H) \sim 2 \times 10^{12}$ cm^{-3}. The ionization of hydrogen is considerable, but by far not complete. The effective thickness of the radiating layer of a prominence is $H = 10^7$ cm. The size of individual elements of the prominence $D \sim 2 \times 10^7$ cm and the weight - 4.10^{10} grams. ("The Electron Density in Solar Prominences," by G. S. Ivanov-Kholodnyy; Moscow, Astronomicheskiy Zhurnal, Vol 36, No 4, Jul/Aug 59, pp 589-600)

Effect of Solar Flocculi on Geomagnetic Disturbances

The geomagnetic disturbances from March to December 1950 and Ca^+ plages, which passed across the center of the solar disk or near it were compared. For the same period, a statistical curve was obtained by the superposed epoch method. This curve confirms the results of the individual comparisons. The geomagnetic disturbances lag behind the CMP (Central meridian passage) of the plages by 3.5 days on the average and the maximum of geomagnetic activity is on phase $+ 5^d$. The same follows from table 1 of Waldmeier's paper (M. Waldmeier, Vistas in Astronomy, 2, 808 (1956) if the index C is used. The introduction of indices C* and P* in Waldmeier's work does not seem to be justified. A shift of curves in the fig 2 (in the article) is due to the decrease of velocity of corpuscles towards the minimum of solar activity. ("The Connection Between the Geomagnetic Disturbances in 1950 and Calcium Plages," by O. N. Mitropolskaya, Crimean Astrophysical Observatory, Academy of Sciences USSR; Moscow, Astronomicheskoy Zhurnal, Vol 36, No 4, Jul/Aug 59, pp 616-619)

III. METEOROLOGY

Attempt to Ascertain Pattern for 24-Hour Humidity Fluctuations in USSR

This work describes an attempt to ascertain by analysis a regular pattern for the 24-hour course of the relative humidity of the air over the territory of the USSR. The results obtained cannot be considered conclusive; the problem requires further investigation. In particular, there is a need for a more detailed study of the influence of local topographical peculiarities on the 24-hour humidity regime.

Charts of the difference in humidity values for 0700 and 1300 were prepared; they characterize only approximately the 24-hour humidity fluctuation. For the period from August to April, for the greater part of the Soviet Union, the difference of the humidity values measured at 0700 and 1300 is almost no different from the actual 24-hour deviation determined by automatic recorders. For the period from May to July, the difference between the 0700 and 1300 values can deviate from the 24-hour difference by 10-15 percent.

The minimum 24-hour fluctuation is observed in the northern USSR. On the coast and islands of the Artic Ocean, in both summer and winter, it amounts to 2-5 percent. The 24-hour humidity fluctuation in winter is not high even in the southern USSR (up to 10-15 percent), whereas, in the southern latitudes, it can exceed 30 percent in summer.

The maximum 24-hour humidity fluctuations are almost universally observed in spring and fall. The charts showing the differences between the 0700 and 1300 values can be used for a study of the approximate change of humidity from the evening observation periods to the day periods, since the humidity value at 0700 is almost no different from the values for 1900 and 2100. ("On the Problem of Studying the 24-Hour Course of the Relative Humidity of the Air," by I. A. Berlin; Leningrad, Trudy Glavnoy Geofizicheskoy Observatorii, No 86, 1958, pp 10-16)

Glacier and Snow Studies Confirm Warming Trend in Climate

An affirmation of the warming trend in climate during recent years has been repeatedly noted in literature. This trend is confirmed by an analysis of a number of observations on Lake Kallavesi in Finland and on the Neva and the Western Dvina rivers, where the duration of the ice period in this century is 2-3 weeks shorter than it was during the preceding 200-year period.

It is natural that the warming of the climate now taking place must somehow also be reflected in the speed with which glaciers retreat. To confirm this theory, the data on the glaciers of Gergeti, Yugo-Vostochnyy, Belengi, Zegitli, Tikhitsar, and others, located in the central and eastern portions of the main Caucasus range where observations were conducted since 1911, were analyzed. The results were tabulated.

The data from these tables show that in recent years the speed of the glaciers' retreat on the whole is greater than in the preceding period. Especially significant deviations in the speed of retreat occur beginning with 1930. The average value of deviation in the speed of retreat for 1860-1920 is minus 3-5, for 1930-1958 is plus 4-10, and more rarely, plus 12-15 meters.

Thus, it can be seen that the speed of the glaciers' retreat in recent years has increased approximately two to three times in comparison with the preceding period.

A similar situation is obtained as a result of the analysis of observational data on the snow line in the region of the Kazbegi glaciation, where a marked increase in the speed with which this limit lifted in recent years was noted. For example, the snow line on the southern slopes of the mountains of Kazbegi in 1911 was at an altitude of 3300-3400 meters, i.e. 70-75 meters higher than in the period of glaciers' maximum development, which is related to the middle of the last century (1850-60). At present (1956), the snow line is at an altitude of 3500-3700 meters, i.e. 200-300 meters higher.

These data confirm that a warming of the climate has now led to an increase in the speed of the rise in the snow line on the slopes of the mountains of Kazbegi by approximately three to four times.

The results obtained on the marked change in the speed of retreat of the Gergeti, Yugo-Vostochnyy, Belengi, Tikhitsar, and Zigitli glaciers and also of changes in the speed of the snow line rise in the region of Kazbegi glaciation can be extended to all of the glacial regions of the Great Caucasus.

This is verified by an analysis of the data of observations on the retreat of Alibek glacier. Thus, for example, during 1954-1955, the frontal edge of the glacier retreated on the average by 6-7 meters, and during 1955-57, by 26-27 meters. ("Change in the Speed of Retreat of Caucasus Glaciers in Connection With the Warming of the Climate," by B. Sh. Tsomaya; Moscow, Meteorologiya i Gidrologiya, No 10, Oct 59, pp 24-25)

IV. OCEANOGRAPHY

New Soviet Ship for Limnological Studies

A research trawler for the limnological (lake studies) station of the Academy of Sciences USSR on Lake Baykal is being built in the Kiev plant, Leninskaya Kuznitsa. This single-screw, all-metal ship, is more than 40 meters long. It contains laboratories and special equipment for hydrobiological, chemical, physical, and hydrometeorological operations, and various other mechanisms and apparatus.

The ship will be transported in sections from Kiev to a shipyard in the Baykal region where it will be assembled and launched. ("Research Ship"; Moscow, Izvestiya, 11 Nov 59, p 2)

V. GLACIOLOGY

Pamir Glacier Expedition Completes Two-Year Study

Scientists of Uzbekistan, in cooperation with scientists from Moscow, Leningrad, China, East Germany, and Poland have conducted complex studies of Pamir glaciers for the past 2 years. The work was conducted under the IGY program.

The results of these operations conducted in the region of the Fedchenko Glacier were revealed by the scientific community of the capital of Uzbekistan. S. V. Starodubtsev, vice-president of the Academy of Sciences Uzbek SSR, noted that material of enormous practical and scientific value was collected under exceptionally severe meteorological conditions at an altitude of 5,000-6,000 meters. The greatest volume of research work on the study of high-mountain glaciers in the world was completed.

Two permanent stations at altitudes of 5,000 and 3,000 meters were established for conducting the work under the IGY program. The staff of the winter stations, according to V. I. Gubin, Doctor of Physicomathematical Sciences and chief of the expedition, organized 24-hour studies of glaciers for the first time. In addition to this, numerous scientific expeditions operated on the glacier each summer.

Much new information in the study of the ice region on the "roof of the world" was obtained. The thickness of the Fedchenko Glacier which feeds many Central Asiatic rivers was established. In its lower part, it ranges from several tens to 240 meters; in its middle part, 700 meters; and in its upper part, 900 meters in thickness.

Studies conducted at the 5,700 meter level showed that the temperature regime in the upper zones of the glacier was similar to the temperature of the free atmosphere, and not of the regime of the perpetual glaciers, as earlier thought.

A detailed geological survey of the valley glacier was conducted for the first time in the history of Pamir glacier studies.

A new map gives a complete presentation of the geological structure of the entire basin and is the first authentic one for prospecting for useful minerals.

Members of the expedition procured data on 30 glaciers, many of which were visited by man for the first time. ("Assignment of the International Geophysical Year Completed"; Moscow, Promyshlenno-Ekonomicheskaya Gazeta, 30 Oct 59, p 4)

VI. SEISMOLOGY

New Seismic Station in Yuzhno-Sakhalinsk

A powerful seismic station, intended for Tsunami warnings, has been opened in Yuzhno-Sakhalinsk. ("From All Corners of the Country"; Moscow, Pravda, 16 Oct 59, p 6)

Magnitude Equation for Surface Waves at Collmberg Seismic Station

Although the Collmberg seismic station began recording in January 1935, not all the data gathered since that time could be used in the derivation of the magnitude equation. Aside from disruptions and damage during the war years, no determinations of constants were made for the seismographs in the period 1946-1948, and only the average magnitude values of the California stations up to 1953 were available to the author at the time of this study. The available data covered 14 years, 1935-1944 and 1949-1952, during which the Wiechert seismographs recorded about 175 earthquakes of appreciable intensity. Some 21 of these had focal depths which excluded their consideration here, while others lay outside the admissible epicentral distance; this work is thus based on data for 109 earthquakes.

A survey of the seismic reports of the Collmberg Observatory showed that the ground motions of surface computed on the basis of the seismograms could not be used, since the latter, in part, contained considerable errors. It was thus found necessary to redetermine, on the basis of the recordings, the periods and amplitudes of the maximum horizontal ground motions for all the earthquakes.

After an estimate was made of the possible error involved in the interpretation of the seismograms, the magnitude equation was derived for the seismic station at Collmberg. A detailed description is given of the difficulties involved. A report also is given of a statistical investigation of the regional deviations, which included a comparison of the Prague regional corrections with the Collmberg data. ("The Derivation of the Magnitude Equation for Surface Waves for the Collmberg Seismic Station," by N. Panner, Geophysics Institute, Karl Marx University, Leipzig; Prague, Studia Geophysica et Geodaetica, No 3, 1959, pp 242-255)

VII. ARCTIC AND ANTARCTIC

Activities at Station Lazarev

The Soviet Antarctic station Lazarev officially began operations on 10 March 1959. A group of seven men remained there during the Antarctic winter. The station buildings cover an area of about 80 square meters, including living and working quarters, radio station, recreation room, electric power station, bathhouse, and storage space for scientific equipment, materials, and food supplies. The buildings are connected by covered passages. The aerological pavilion and two small huts with emergency supplies of fuel, food, and clothing are located separately. A reserve base was built 9 kilometers southeast of the station.

At first, only meteorological observations were conducted at the station. Magnetic observations were organized later. Remote-control instruments were installed on a platform, making it possible to determine at any time, without leaving the building, the direction and speed of the wind and temperature of the air.

At the end of March, N. Lukavishnikov, aerologist, began the daily launching of radiosondes. The results of meteorological and aerological observations were transmitted to Mirnyy for use in the preparation of synoptic weather forecasts. Yu. Kruchinin, chief of the station, was engaged in a study of the ice shelf on which the station is located. The study included a determination of the rhythm (regularity) of its accumulation by atmospheric precipitation during different seasons of the year, the ablation process by melting in the summer, as well as by calving of icebergs, the speed of movement, and surface relief.

The autumn weather at Lazarev was very stormy. Series of cyclones moving from the west brought raging winds. The month of April was especially severe. The storm raged for 20 days, often reaching hurricane force. The average wind speed exceeded 21 meters per second. Several times the wind force exceeded the maximum scale value of the hurricane meter, which is designed for a maximum wind velocity of 60 meters per second.

The winter, which set in early in May, produced no significant changes in the surrounding snow wilderness. Hurricane-force winds continued; however, the wind velocity diminished to 30-40 meters per second, with only occasional gusts of over 50 meters per second.

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The storm periods lasted from 3 to 12 days. One of the storms broke up the newly formed shore ice and carried the ice fragments out to the west. Therefore, the sea near the station was usually free of ice up to the middle of August. On 3 September, the temperature was around minus 47 degrees centigrade.

During the polar night, the sun did not appear above the horizon; however, around noon the sky in the north would lighten a little and there was a period of twilight, resembling the "white nights" in Leningrad. Auroras and magnetic storms became more frequent, causing disturbances and sometimes even disruption of radio contacts. I. Ozerov, senior radio technician, made certain changes, which he hoped would improve the passage of radio waves.

Activities at the station take place according to a definite schedule of scientific observations. Recently [i.e., in early October] the staff members took some trips by snow vehicle in the vicinity of the station to make an approximate topographic survey of the ice shelf area, and to obtain more definite information on the new location of its western edge after the intensive calving of icebergs during the polar night. It appeared that the principal area of iceberg formation is 20 kilometers north of the station, where a wide inlet, penetrating far into the ice shelf, has formed. Several small icebergs calved from the edge of the ice shelf at a distance of 3-5 kilometers northwest of the station. The largest of them were 3 kilometers in diameter and their average height was 30-35 meters. ("Antarctica, Station Lazarev," Leningradskaya Pravda, 15 Oct 59)

Station Vostok Expecting New Group of Scientists

The polar day has begun in the area of Station Vostok. The sun no longer disappears below the horizon, and the weather is clear and cloudless. The temperature fluctuates between 45 and 65 degrees Centigrade, and the winds have diminished considerably.

In addition to conducting scientific observations, the station staff is now busy preparing a landing strip for the plane expected to arrive from Mirnyy. The station area is being cleared from snow drifts.

The station staff members are looking forward to the arrival of the plane and the sled-tractor train. These will be the first visitors after an 8-month wintering period. A group of scientific associates is expected to arrive by plane for conducting field research. ("From the Interior of Antarctica," Moscow, Vodnyy Transport, 29 Oct 59)

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